MAR 10 1988

594 c-09

FEM 1.209:330232

FLOOD INSURANCE STUDY

ORIGINAL

TOWN OF NORTH HAMPTON, NEW HAMPSHIRE
ROCKINGHAM COUNTY

JUNE 3, 1986

Federal Emergency Management Agency

COMMUNITY NUMBER - 330232

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
	1.1 Purpose of Study	1
	1.2 Authority and Acknowledgments	1
	1.3 Coordination	1
2.0	AREA STUDIED	2
	2.1 Scope of Study	2
	2.2 Community Description	2
	2.3 Principal Flood Problems	4
	2.4 Flood Protection Measures	6
3.0	ENGINEERING METHODS	6
	3.1 Hydrologic Analyses	6
	3.2 Hydraulic Analyses	9
4.0	FLOOD PLAIN MANAGEMENT APPLICATIONS	12
	4.1 Flood Boundaries	12
	4.2 Floodways	14
5.0	INSURANCE APPLICATION	18
	5.1 Reach Determinations	18
	5.2 Flood Hazard Factors	18
	5.3 Flood Insurance Zones	20
	5.4 Flood Insurance Rate Map Description	21

BEST COPY AVAILABLE

TABLE OF CONTENTS - continued

	Page
6.0 OTHER STUDIES	21
7.0 LOCATION OF DATA	22
8.0 BIBLIOGRAPHY AND REFERENCES	22

FIGURES

Figure 1 - Vicinity Map	3
Figure 2 - Flood Photograph in North Hampton during February 1978	5
Figure 3 - Transect Location Map	13
Figure 4 - Floodway Schematic	15

TABLES

Table 1 - Summary of Discharges	7
Table 2 - Summary of Stillwater Elevations	8
Table 3 - Floodway Data	16 - 17
Table 4A - Flood Insurance Zone Data	19
Table 4B - Flood Insurance Zone Data	20

EXHIBITS

Exhibit 1 - Flood Profiles	
Little River	Panels 01P - 02P
Winnicut River	Panel 03P
Exhibit 2 - Flood Boundary and Floodway Map Index	
Flood Boundary and Floodway Map	

BEST COPY AVAILABLE

EXHIBITS - continued

Exhibit 3 - Coastal Profiles
Transects 1 - 2 Panels 01C - 02C

PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index
Flood Insurance Rate Map

BEST COPY AVAILABLE

FLOOD INSURANCE STUDY
TOWN OF NORTH HAMPTON, NEW HAMPSHIRE

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Town of North Hampton, Rockingham County, New Hampshire, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in their efforts to promote sound flood plain management. Minimum flood plain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The initial hydrologic and hydraulic analyses for this study were prepared by Stone & Webster Engineering Corporation for the Federal Emergency Management Agency (FEMA), under Contract No. H-4772. This work was completed in February 1984.

1.3 Coordination

On April 19, 1978, an initial Consultation and Coordination Officer's (CCO) meeting was held with representatives of FEMA, the Town of North Hampton, and Stone & Webster Engineering Corporation (the study contractor). Coordination with town officials and federal, regional, and state agencies produced a variety of information pertaining to flood plain regulations, available community maps, past flood history, and other hydrologic data.

BEST COPY AVAILABLE

Analyses of Atlantic Ocean flood levels were coordinated with the U. S. Army Corps of Engineers (COE) and the National Oceanic and Atmospheric Administration. The New Hampshire Department of Public Works and Highways (DPWH) provided information on historic flooding and high-water marks. Vertical control data used to establish the network of elevation reference marks were provided by the New Hampshire DPWH, the U. S. Geological Survey (USGS), the National Oceanic and Atmoshpheric Administration, and the U. S. Coast & Geodetic Survey (USC&GS).

An intermediate CCO meeting was conducted to present preliminary results of the study to town officials. On January 16, 1985, the results of the study were reviewed at a final CCO meeting attended by representatives of FEMA, the town, and the study contractor.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the Town of North Hampton, Rockingham County, New Hampshire. The area of study is shown on the Vicinity Map (Figure 1).

Tidal flooding including its wave action from the Atlantic Ocean was studied by detailed methods. Riverine flooding from the Little River and the Winnicut River was also studied by detailed methods. The Little River was studied from Woodland Road to Mill Pond Dam along with the Little River Swamp, and the Winnicut River was studied from Line Swamp to the corporate limits. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction through February 1989.

Line Swamp, Mill Pond, and portions of the Little River were studied by approximate methods. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and the Town of North Hampton.

2.2 Community Description

The Town of North Hampton is located in Rockingham County in southeastern New Hampshire, approximately 7 miles south of Portsmouth and 50 miles north of Boston, Massachusetts. It is bordered by the Town of Rye and the Atlantic Ocean to the east, the Town of Hampton to the south, the Town of Stratham to the west, and the Towns of Greenland and Rye to the north.

BEST COPY AVAILABLE

PORTSMOUTH
Exeter
Hampton
Amesbury
Salisbury
Newburyport
Rye
Rye Harbor State Pk
Isles Of Shoals Light
ATLANTIC OCEAN
MAINE
NEW HAMPSHIRE
Hampton Beach
Salisbury Beach
Plum Island Point
Plum Island
Duck Island
Appledore Island
Smuttynose Island
Star Island
White Island
Little Boars Head
Great Boars Head
Rye Beach
North Beach
Seabrook Beach
Coast guard tower
Straw Point
Beckmans Point
Hampton Flats
Woodbridge Island
Odiorne Pt
Fort Stark
Fort Foster
Pierce Island
Newington
Newmarket
Durham
Kittery
York Village
York Harbor
Godfreys Cove
Brave Boat Harbor
Seapoint Beach
Wallis Sands
Rye N Beach
Jenness Beach
Rye Harbor
Pease AFB
Portsmouth Harbor
Little Harbor
Newcastle
Light
Kittery Point
Rachel Carson Refuge
Great Bay
Squamscott River
Piscassic River
Lamprey River
Berrys Brook
Spruce Creek
Back River
Oyster River
Cedar Point
Adams Pt
Fabyan Pt
Woodman Pt
Greenland
Stratham
Newfields
Epping
Brentwood
Kingston
East Kingston
South Hampton
North Hampton
Hampton Falls
Seabrook
South Seabrook
Newton Junction
Plaistow
Haverhill
Merrimac
Bradford
Groveland
Boston
Maine
New Hampshire
Massachusetts
Rockingham Co
Strafford Co
Essex Co
Boston & Maine R.R.
Eastern R.R.
Portsmouth & Dover R.R.
Newburyport Branch
Lowell Branch
Amesbury Branch
Exeter Branch
Kensington Branch
Haverhill Branch
Lowell Tower
Coast guard tower
Whittier State Forest
Cedar Swamp
Cedar Pond
Cedar Waters
Nathaniel Dam
Mill Pond
Quimby Pond
Country Pond
Kennard Hill
Bald Hill
Camp Hedding
Great Hill
Deer Hill
Prescott Hill
Stratham Hill
Green Hill
Burn Hill
Moose Hill
Red Oak Hill
Long Hill
Artis Hill
Pleasant Hill
Parsons Hill
Dows Corner
Marshall Corner
Brentwood Corners
Austins Corners
Eastman Corner
Hoag Corner
Kingston Brick Co
Elmwood Corners
Lafayette Rd
Ocean Blvd
Route 1
Route 1A
Route 1B
Route 101
Route 95
Route 108
Route 286
Route 27
Route 33
Route 111
Route 125
Route 150
Route 84
Route 85
Route 88
Route 107
Route 51
Route 54
Route 97

North Hampton is a rural residential community. According to the 1976 state census, North Hampton had a population of 3,240 and a population density of 248 persons per square mile; its 1976 population increased 4.9 percent from its 1970 population (Reference 1). It is estimated that the population of the town will increase approximately 134 percent between 1976 and 1990 (Reference 2).

The total land area contained within the corporate limits of North Hampton is 14 square miles. Development along the coast is primarily residential and recreational. Summer resorts line the coast. The coast is characterized by sandy beaches, rocky headlands, and offshore reefs and ledges. Little River Swamp abuts the coastal development along the western section of town. There are also wetlands along the western corporate limits. The North Hampton town center is located approximately 4 miles inland of the coast.

Topographically, the coast of North Hampton is relatively flat, with elevations ranging from sea level to 20 feet. Inland from the coast, the topography is rolling, reaching elevations of approximately 120 feet (Reference 3).

North Hampton has a variable climate. The average annual precipitation is approximately 43 inches. There is no dry season. From June to September, rainfall usually occurs as showers or thunderstorms. Throughout the year, the heaviest gales are usually from the northeast or east and are more common and severe during the winter. The coastal northeasters produce an abundance of rain and snow. The average annual temperature is in the mid-forties on the Fahrenheit scale (Reference 4).

2.3 Principal Flood Problems

The low-lying coastal areas of North Hampton are subject to the periodic flooding and wave attack that accompany coastal storms, such as northeasters and hurricanes. The majority of these storms cause damage only to low coastal highways, boats, beaches, and seawalls. Occasionally, a major storm accompanied by strong onshore winds and high tides results in surge and wave activity that causes extensive property damage and erosion. Some of the more significant storms in the North Hampton area include those of November 1945, 1963, and 1968, and February 1972 and 1978. These storms damaged harbors, marinas, commercial developments, and residential developments in the flood-prone coastal areas.

Figure 2 shows flood damage in North Hampton from the February 1978 northeaster.

BEST COPY AVAILABLE

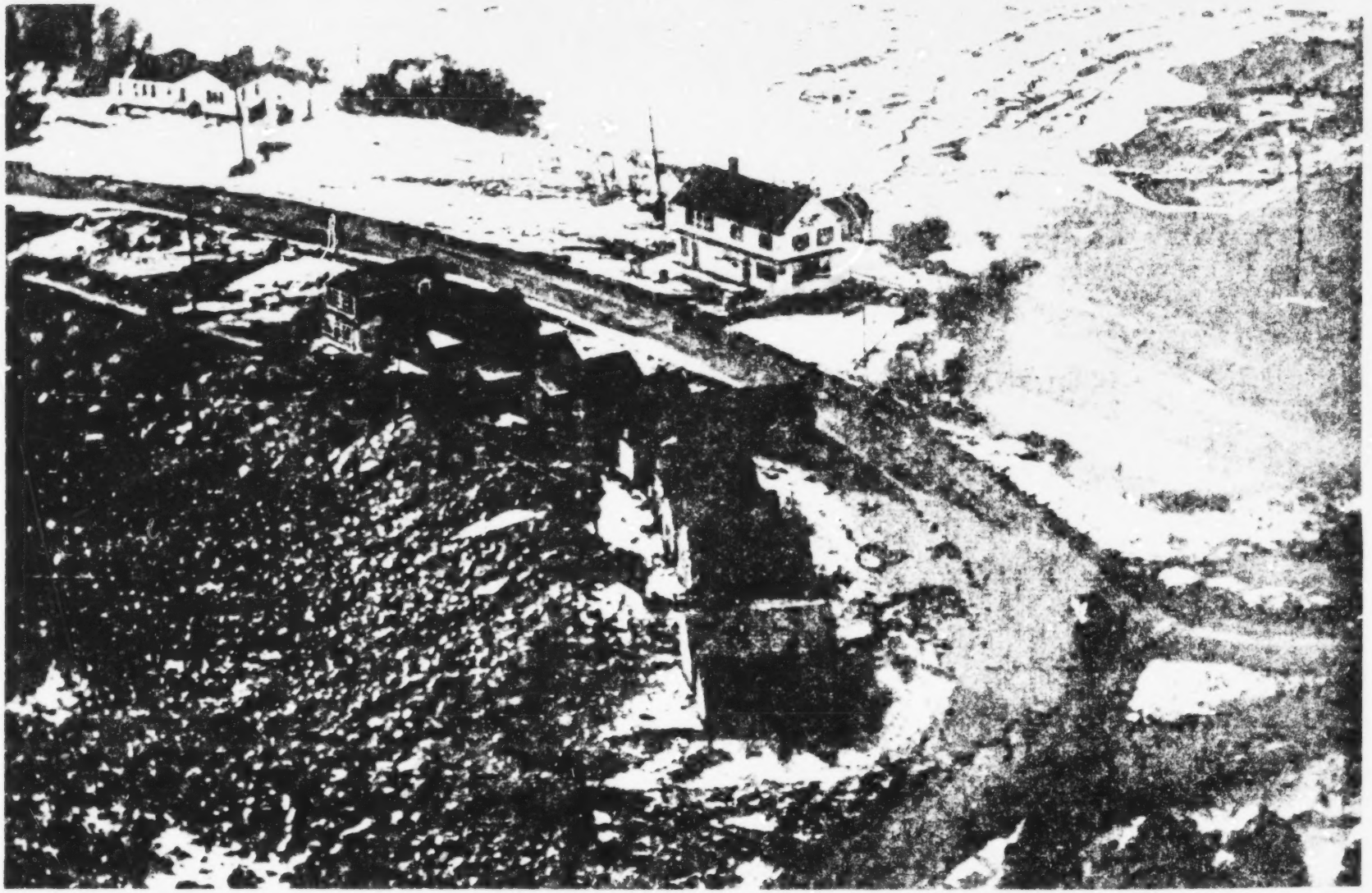


Figure 2. Aerial view of a fish house that was carried off its foundation onto Route 1A in North Hampton during the northeaster of February 1978.

2.4 Flood Protection Measures

The State of New Hampshire provides concrete seawalls and stone revetments to protect coastal highways. Other protective structures were constructed and are maintained by the local municipality and private property owners to satisfy their individual requirements and financial capabilities. These structures include such backshore protection as timber and steel sheetpiles, bulkheads, stone revetments, concrete seawalls, and pre-cast concrete units (Reference 5). Limited financial resources sometimes result in less than adequate protection.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency and peak elevation-frequency relationships for the flooding sources studied in detail affecting the community.

The streams in North Hampton are ungaged; therefore, the 10-, 50-, and 100-year discharges for the Little River and the Winnicut River were computed based on the New Hampshire flood magnitude and frequency formulas developed by the USGS (Reference 6). The study contractor performed a separate evaluation of these formulas and found them to be applicable to the North Hampton region. These formulas were then used to develop an equation to determine the 500-year flood. The USGS formulas predict discharges based on the parameters of watershed drainage area, main channel slope, and rainfall intensity.

BEST COPY AVAILABLE

A summary of drainage area-peak discharge relationships for the Little River and the Winnicut River is shown in Table 1, "Summary of Discharges."

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
LITTLE RIVER					
At Ocean Boulevard	4.67	118	189	226	330
WINNICUT RIVER					
At the downstream corporate limits	5.97	113	168	198	275

In New England, the flooding of low-lying coastal areas is caused primarily by storm surges generated by extratropical coastal storms called northeasters. Hurricanes also occasionally produce significant storm surges in New England, but they occur infrequently as compared to northeasters.

To calculate the storm surge and total stillwater elevations produced by historic storms, it was necessary to determine the storm pressure and wind fields. A computer model was developed by the study contractor to simulate these fields based on several, easily obtained, northeaster storm parameters. A detailed description of this model is presented in the report entitled Development and Verification of a Synthetic Northeaster Model for Coastal Flood Analysis (Reference 7). A different model was used to simulate the wind and pressure fields of the hurricanes considered in this analysis (Reference 8). When coupled with a computer surge model, the storm tide along the shoreline could be calculated for each storm of interest.

Synoptic weather maps were searched to determine the northeasters and hurricanes that could potentially produce significant flooding in the North Hampton area. Tidal records from tide gages in the New England area were examined to verify which historic storms produced high-water elevations. A total of 165 storms, from 1942 to 1978, was considered in the analysis of flood levels.

The flood levels associated with historic storms were simulated using a modified version of the FEMA storm surge model (References 9 and 10). Input to the model consisted of wind and pressure fields generated either by the synthetic northeaster model or a hurricane wind and pressure field

BEST COPY AVAILABLE

model for each historic storm selected. The study area was modeled using a square grid of sufficient resolution to accurately represent the offshore bathymetry and shoreline configuration. The grid mesh covered an area from Cape Cod Bay to north of Portsmouth, New Hampshire, including Boston Harbor. Output from the model included the time history of storm-induced surge elevations in the study area. These elevations were combined with the predicted astronomical tide for the same time period to produce total stillwater elevations for the communities in the study area. The total stillwater elevation was calibrated using historic tide elevation data at Boston, Massachusetts, and Portsmouth, New Hampshire. Thus, the historic storm-induced flood levels in North Hampton could be simulated for each storm considered in the analysis.

The extent and frequency of recurrence of coastal flooding were determined by conducting a frequency analysis of annual maximum tidal heights along the coastline of North Hampton. Some historic stillwater heights, consisting of an astronomical tide and a storm surge contribution, were determined by the mathematical simulation of historic northeasters and hurricanes as described above; others, for which associated storm data were not available, were obtained by a correlation analysis using tide data from Boston or Portsmouth. The data base at the Boston gage extended from 1978 discontinuously back to 1948; the shorter record at Portsmouth was lengthened by a statistical correlation with data at Boston and Portland. The annual maxima of these reproduced historic stillwater elevations were fitted with a Pearson Type III distribution. The goodness of fit was tested with the chi-square test and accepted at the 95 percent confidence level. A detailed description of the methodology employed in this analysis can be found in the report entitled Determination of Coastal Storm Tide Levels (Reference 10).

The stillwater elevations for the 10-, 50-, 100-, and 500-year floods have been determined for the Atlantic Ocean and are summarized in Table 2.

TABLE 2 - SUMMARY OF STILLWATER ELEVATIONS

FLOODING SOURCE AND LOCATION	ELEVATION (feet) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
ATLANTIC OCEAN				
Entire shoreline within community	8.3	8.9	9.2	9.8

BEST COPY AVAILABLE

The analyses reported in this study reflect the stillwater elevations due to tidal and wind setup effects. The effects of wave action were also considered in the determination of flood hazard areas. Coastal structures which are located above stillwater flood elevations can still be severely damaged by wave runup, wave-induced erosion, and wave-borne debris. For example, during the February 1978 northeaster, considerable damage along the New Hampshire coast was caused by wave activity, even though most of the damaged structures were above the high-water level. The extent of wave runup past stillwater levels depends greatly on the wave conditions and local topography.

Wave heights and corresponding wave crest elevations were determined using the National Academy of Sciences (NAS) methodology (Reference 11). The wave runup was determined using the methodology developed by Stone & Webster Engineering Corporation for FEMA (Reference 12).

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the riverine sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Cross-sectional data were obtained from photogrammetric maps (Reference 13); below-water sections were obtained from field surveys. All bridges and culverts were field surveyed to obtain elevation data and structural geometry.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Channel roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment and based on observations of the streams and flood plain areas. The channel "n" values for the Winnicut River ranged from 0.020 to 0.050, and the overbank "n" value was 0.070. The channel "n" values for the Little River ranged from 0.013 to 0.040, and the overbank "n" value was 0.100.

For inland reaches of rivers, water-surface elevations of floods of the selected recurrence intervals were computed using the COE HEC-2 step-backwater computer program (Reference 14). The water-surface elevations for the Little River Swamp were obtained from a volume/elevation study. Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

BEST COPY AVAILABLE

Starting water-surface elevations for the Little River were based on the critical depth method. The elevations for the Winnicut River were based on the slope/area method.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

Existing approximate flood hazard zones were reviewed using information from community officials, residents, and the most recent FEMA criteria. These criteria consisted of the size of surface area of lakes and ponds, the size of contributing drainage area, the depth of flow, and the width of the flood plain. The Flood Insurance Rate Map (Exhibit 2) reflects these modifications.

Hydraulic analyses, considering storm characteristics and the shoreline and bathymetric characteristics of the tidal flooding source studied, were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each of the shorelines.

Areas of coastline subject to significant wave attack are referred to as coastal high hazard zones. The COE has established the 3-foot breaking wave as the criterion for identifying the limit of coastal high hazard zones (References 15). The 3-foot wave has been determined as the minimum size wave capable of causing major damage to conventional wood frame or brick veneer structures.

A wave height analysis was performed to determine wave heights and corresponding wave crest elevations for the areas inundated by the tidal flooding. A wave runup analysis was performed to determine the height and extent of runup beyond the limit of tidal inundation. The results of these analyses were combined into a wave envelope, which was constructed by extending the maximum wave runup elevation seaward to its intersection with the wave crest profile.

The methodology for analyzing wave heights and corresponding wave crest elevations was developed by the NAS (Reference 11). The NAS methodology is based on three major concepts.

First, a storm surge on the open coast is accompanied by waves. The maximum height of these waves is related to the depth of water by the following equation:

$$H_b = 0.78d$$

BEST COPY AVAILABLE

where H_b is the crest to trough height of the maximum or breaking wave and d is the stillwater depth. The elevation of the crest of an unimpeded wave is determined using the equation:

$$Z_w = S_* + 0.7H_* = S_* + 0.55d$$

where Z_w is the wave crest elevation, S_* is the stillwater elevation at the site, and H_* is the wave height at the site. The 0.7 coefficient is the portion of the wave height which reaches above the stillwater elevation. H_b is the upper limit for H_*.

The second major concept is that the breaking wave height may be diminished by dissipation of energy by natural or man-made obstructions. The wave height transmitted past a given obstruction is determined by the following equation:

$$H_t = BH_i$$

where H_t is the transmitted wave height, H_i is the incident wave height, and B is a transmission coefficient ranging from 0.0 to 1.0. The coefficient is a function of the physical characteristics of the obstruction. Equations have been developed by the NAS to determine B for vegetation, buildings, natural barriers such as dunes, and man-made barriers such as breakwaters and seawalls (Reference 11).

The third concept deals with unimpeded reaches between obstructions. New wave generation can result from wind action. This added energy is related to distance and mean depth over the unimpeded reach.

The methodology for analyzing wave runup was developed by Stone and Webster Engineering Corporation (Reference 12). The wave runup computer program operates using an ensemble of deepwater wave heights, H_i, the stillwater elevation, S*, a wave period, T_s, and beach slope, m. For North Hampton, wave heights range from 3 feet up to the significant wave height of 30 feet; the wave period ranges from 7 to 14 seconds.

These concepts and equations were used to compute wave envelope elevations associated with the 100-year storm surge. Accurate topographic, land-use, and land cover data are required for the coastal analyses. Maps of the study area, at a scale of 1:2,400 with a contour interval of 5 feet, were used for the topographic data (Reference 13). The land-use and land cover data were obtained by field surveys.

Wave heights and wave runup were computed along transects which were located perpendicular to the average mean shoreline. The transects were located with consideration given to the physical and cultural characteristics of the land so that they would closely represent conditions in

BEST COPY AVAILABLE

their locality. Transects were spaced close together in areas of complex topography and dense development. In areas having more uniform characteristics, the transects were spaced at larger intervals. It was also necessary to locate transects in areas where unique flooding existed and in areas where computed wave heights varied significantly between adjacent transects. Figure 3, "Transect Location Map," illustrates the location of the transects for the community.

Along each transect, wave envelope elevations were computed considering the combined effects of changes in ground elevation, vegetation, and physical features. Between transects, elevations were interpolated using the topographic maps, land-use and land cover data, and engineering judgment to determine the areal extent of flooding. The results of the calculations are accurate until local topography, vegetation, or cultural development within the community undergo any major changes. The selected beach transects with wave envelope profiles for the 10- and 100-year recurrence intervals are shown on the Coastal Profiles (Exhibit 1).

Historic flood damage information was also used to ensure reasonable delineation of flood prone areas along the North Hampton shoreline (Reference 16).

All elevations used in this study are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used are shown on the maps.

Areas of shallow flooding have been determined for the lee side of the dunes along the Atlantic Ocean. In these areas, the wave runup elevation exceeded the dune crest elevation. The difference between the runup elevation and the dune crest was used to determine the depth of shallow flooding behind the dune.

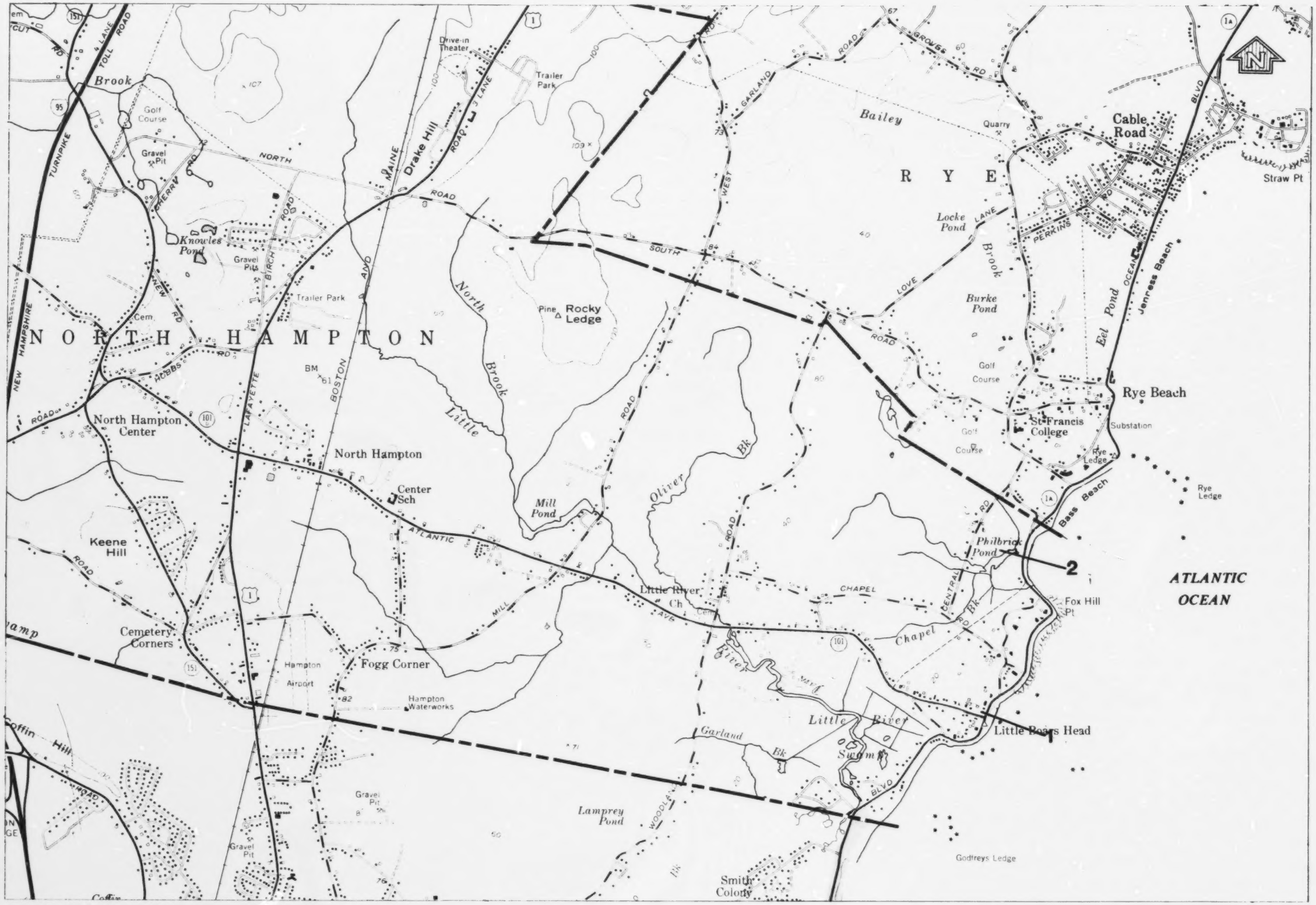
4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages State and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing flood plain management measures.

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for flood plain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood

BEST COPY AVAILABLE


NORTH HAMPTON
RYE
ATLANTIC OCEAN
Drake Hill
Knowles Pond
Gravel Pit
Trailer Park
Golf Course
Cem.
North Hampton Center
North Hampton
Center Sch
Keene Hill
Cemetery Corners
Hampton Airport
Fogg Corner
Hampton Waterworks
Coffin Hill
Gravel Pit
Lamprey Pond
Smith Colony
Mill Pond
Rocky Ledge
Pine
North Brook
Little Brook
Oliver Bk
Little River Ch
Cem.
Chapel Bk
Garland Bk
Little River Swamp
Little Boars Head
Philbrick Pond
Fox Hill Pt
Godfreys Ledge
Bailey
Quarry
Cable Road
Straw Pt
Locke Pond
Burke Pond
Eel Pond
Jenness Beach
Rye Beach
St Francis College
Substation
Rye Ledge
Bass Beach
Drive-in Theater
Trailer Park
Golf Course
Golf Course
Golf Course
Brook
Brook
Brook

risk in the community. For each stream studied in detail, the 100- and 500-year flood plain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps (Reference 13).

For tidal areas without wave action, the 100-year and 500-year boundaries were delineated using tne topographic maps referenced above (Reference 13). For the tidal areas with wave action, the flood boundaries were delineated using the elevations determined at each transect; between transects, the boundaries were interpolated using engineering judgment, land-cover data, and the topographic maps referenced above. The 100-year flood plain was divided into whole-foot elevation zones based on the average wave envelope elevation in that zone. Where the map scale did not permit these zones to be delineated at one foot intervals, larger increments were used.

For the streams studied by approximate methods, only the 100-year flood boundary is shown. Approximate flood boundaries were delineated using topographic maps (Reference 13). Shallow flooding areas were also delineated using topographic maps (Reference 13).

The 100- and 500-year flood plain boundaries are shown on the Flood Boundary and Floodway Map (Exhibit 2). In cases where the 100- and 500-year flood plain boundaries are close together, only the 100-year flood plain boundary has been shown. Small areas within the flood plain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

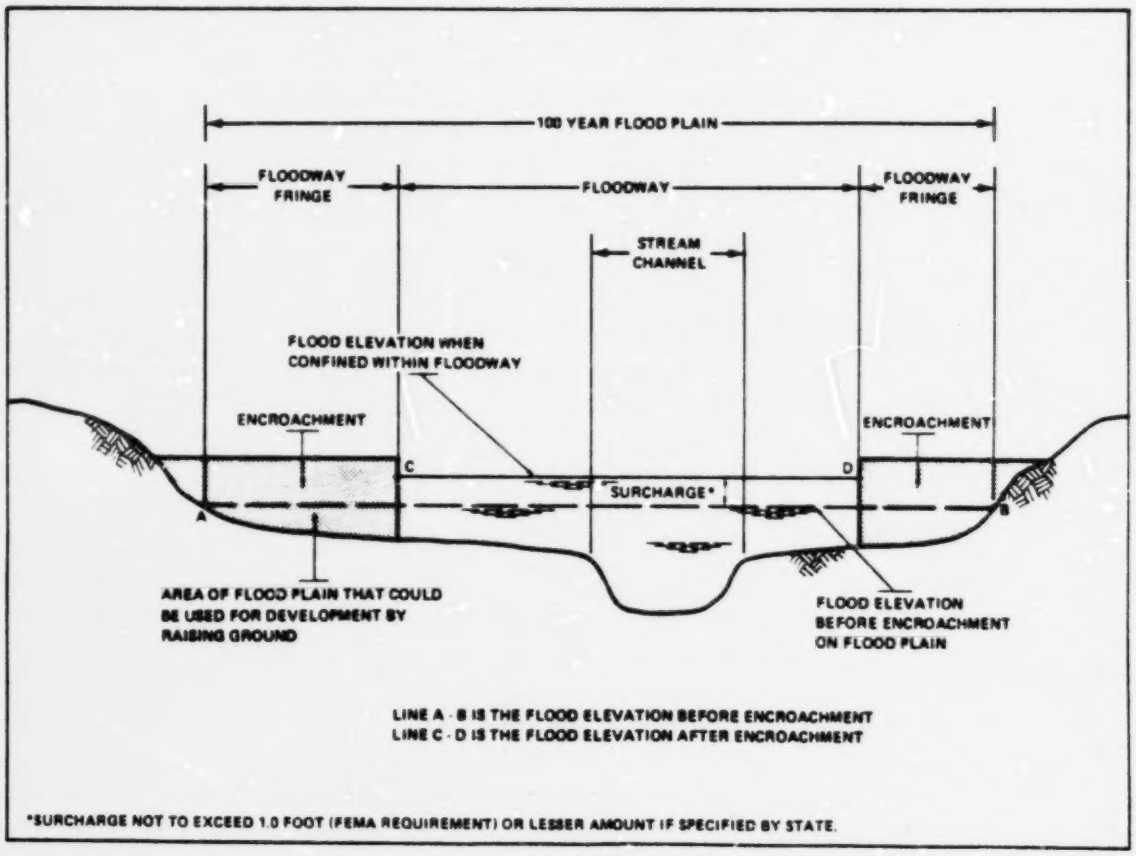
Encroachment on flood plains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood plain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent flood plain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study is presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

BEST COPY AVAILABLE

The floodways presented in this study was computed on the basis of equal conveyance reduction from each side of the flood plain. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 3).

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the floodway and 100-year flood plain boundaries are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and 100-year flood plain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 4.


100 YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
"SURCHARGE"
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE A - B IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE C - D IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

FLOODWAY SCHEMATIC

Figure 4

BEST COPY AVAILABLE

BEST COPY AVAILABLE

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Little River								
A	3,048[1]	67	302	0.7	10.0	10.0	10.1	0.1
B	5,048[1]	*	78	2.9	10.3	10.3	10.8	0.5
C	5,185[1]	*	59	3.8	10.7	10.7	11.1	0.4
D	5,385[1]	*	32	7.2	12.5	12.5	12.5	0.0
E	5,490[1]	*	31	7.3	14.5	14.5	14.7	0.2
F	5,780[1]	*	25	9.0	21.6	21.6	21.7	0.1
G	6,420[1]	*	31	7.4	27.0	27.0	27.0	0.0
H	6,495[1]	*	32	7.2	31.6	31.6	31.7	0.1
I	6,561[1]	75	410	0.6	35.3	35.3	35.5	0.2
J	6,771[1]	*	25	9.0	35.5	35.5	35.5	0.0
K	6,867[1]	*	49	4.6	39.0	39.0	39.0	0.0
Winnicut River								
A	1,200[2]	32	112	1.8	41.6	41.6	41.6	0.0
B	3,040[2]	*	112	1.8	42.5	42.5	43.3	0.8
C	4,240[2]	97	261	0.8	43.0	43.0	44.0	1.0
D	4,372[2]	51	239	0.8	45.2	45.2	45.2	0.0
E	6,272[2]	*	74	2.7	45.3	45.3	45.8	0.5
F	7,472[2]	54	223	0.9	45.5	45.5	46.2	0.7
G	7,662[2]	*	126	1.6	49.4	49.4	49.6	0.2
H	9,762[2]	505	2,667	0.1	49.4	49.4	49.6	0.2
I	12,322[2]	90	581	0.3	49.4	49.4	49.7	0.3
J	13,842[2]	256	630	0.3	49.4	49.4	49.7	0.3

[1]Feet above downstream dam

[2]Feet above corporate limits

*Floodway coincident with channel banks

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NORTH HAMPTON, NH
(ROCKINGHAM CO.)

FLOODWAY DATA

LITTLE RIVER–WINNICUT RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Winnicut River (continued)								
K	14,056	250	1,866	0.1	53.2	53.2	53.3	0.1
L	15,056	240	1,060	0.2	53.2	53.2	53.3	0.1
M	15,279	340	3,607	0.1	56.5	56.5	56.5	0.0

[1]Feet above corporate limits

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NORTH HAMPTON, NH

(ROCKINGHAM CO.)

FLOODWAY DATA

WINNICUT RIVER

BEST COPY AVAILABLE

5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail in the Town of North Hampton.

5.1 Reach Determinations

Reaches are defined as sections of flood plain that have relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following tabulation for more than 20 percent of the reach:

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the riverine flooding sources of the Town of North Hampton are shown on the Flood Profiles (Exhibit 1) and summarized in Table 4A.

In areas where wave height and wave runup analyses were performed, reaches were determined for areas of the coastline, represented by a transect or group of transects, which have the same physical characteristics. For each transect the coastal high hazard zone (V zone) may be divided into two reaches to reflect those areas where wave runup is a dominant factor and those areas where wave runup does not dominate and elevations are determined by the wave height analysis. The reaches determined for the Town of North Hampton are summarized in Table 4B.

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

BEST COPY AVAILABLE

BLANK PAGE

BLANK PAGE

BLANK PAGE

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Little River							
Reach 1	04	-1.8	-0.8	+1.5	020	A4	Varies
Reach 2	04	-0.5	-0.2	+0.4	005	A1	Varies
Winnicut River							
Reach 1	01	-0.5	-0.2	+0.3	005	A1	Varies
Reach 2	01,03	-0.8	0.0	+0.4	010	A2	Varies
Reach 3	03	-1.6	-0.6	+1.6	015	A3	49
Reach 4	03	-2.3	-0.2	+0.3	025	A5	Varies
Reach 5	03	-4.2	-0.4	+0.4	040	A8	57

[1]Flood Insurance Rate Map Panel
[2]Weighted Average
[3]Rounded to the nearest foot - see map

TABLE 4A

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NORTH HAMPTON, NH
(ROCKINGHAM CO.)

FLOOD INSURANCE ZONE DATA

LITTLE RIVER-WINNICUT RIVER

BEST COPY AVAILABLE

TABLE 4B - FLOOD INSURANCE ZONE DATA

Flooding Source	Stillwater Elevation 10-Year	Stillwater Elevation 100-Year	FHF	Zone	Base Flood Elevation (Feet NGVD)*
Atlantic Ocean	8.3	9.2	010	V2	14-23
			010	A2	9
Shallow Flooding - Average Depth 1.0 Foot				AO	--

*Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one-half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF, and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

Zone A: Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined.

Zone AO: Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths are between 1.0 and 3.0 feet; depths are shown but no FHFs are determined.

Zones A1, A2, A3, A4, A5, and A8: Special Flood Hazard Areas inundated by the 100-year flood; with base flood elevations shown, and zones subdivided according to FHFs.

BEST COPY AVAILABLE

Zone V2: Special Flood Hazard Areas along coasts inundated by the 100-year flood that have additional velocity hazards associated with waves of 3-foot amplitude or greater; with base flood elevations shown, and zones subdivided according to FHFs.

Zone B: Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- or 500-year floods by dike, levee, or other water control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.

Zone C: Areas of minimal flooding; not subdivided.

Flood elevation differences, FHFs, flood insurance zones, and base flood elevations for the flooding source studied in detail in the community are shown in Tables 4A and 4B.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the Town of North Hampton is, for insurance purposes, the principal result of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevations. Base flood elevation lines show the locations of the expected whole-foot water-surface elevation of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the National Flood Insurance Program.

6.0 OTHER STUDIES

Using National Ocean Survey tide gage data, the COE predicted 10-, 50-, 100-, and 500-year flood levels at Boston, Massachusetts, and Portsmouth, New Hampshire. Their results compare favorably with flood elevations determined in this study considering the distance between North Hampton and the National Ocean Survey gaging stations.

The Flood Insurance Studies for the Towns of Hampton, Rye, Stratham, and Greenland are currently being prepared (References 17, 18, 19, and 20). The results of these studies will be in exact agreement with the results of this

BEST COPY AVAILABLE

study for North Hampton, except at the location where the Winnicut River enters the Town of Hampton. The Winnicut River is studied by approximate methods in the Hampton study and by detailed methods in this study.

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, Regional Director, Region I Office, J. W. McCormack Post Office and Courthouse Building, Room 462, Boston, Massachusetts 02109.

8.0 BIBLIOGRAPHY AND REFERENCES

1. New Hampshire Office of Comprehensive Planning, "1976 New Hampshire Resident Population Figures," New Hampshire, 1976.

2. New Hampshire Office of Comprehensive Planning, "New Hampshire Population Projections for Towns and Cities to the Year 2000," New Hampshire, November 1975.

3. New Hampshire Office of Comprehensive Planning, "Existing Land Use - 1975," New Hampshire, April 1976.

4. U. S. Department of Commerce, National Oceanic and Atmospheric Administration, United States Coast Pilot 1, Atlantic Coast, Eastport to Cape Cod, Asheville, North Carolina, National Climatic Center, November 1976.

5. U. S. Army Corps of Engineers, North Atlantic Division, National Shoreline Study, Regional Inventory Report, North Atlantic Region, Volume I, New York, 1971.

6. U. S. Department of the Interior, Geological Survey, Water Resources Investigations 78-47, Progress Report on Hydrologic Investigations of Small Drainage Areas in New Hampshire, Preliminary Regulations for Estimating Peak Discharges on Rural Unregulated Streams by D. R. LeBlanc, Washington, D. C.

7. Stone & Webster Engineering Corporation, Development and Verification of a Synthetic Northeaster Model for Coastal Flood Analysis, Boston, Massachusetts, October 1978.

8. Stone & Webster Engineering Corporation, Two Dimensional Coastal Storm Surge Model, SWECO 7501-NP-A, Boston, Massachusetts, July 1977.

BEST COPY AVAILABLE

9. Tetra Tech, Inc., Coastal Flooding Handbook, Parts I and II, Pasadena, California, May 1977.

10. Stone & Webster Engineering Corporation, Determination of Coastal Storm Tide Levels, Boston, Massachusetts, October 1978.

11. National Academy of Sciences, Methodology for Calculating Wave Action Effects Associated with Storm Surges, Washington, D. C., 1977.

12. Stone & Webster Engineering Corporation, Manual for Wave Runup Analysis, Coastal Flood Insurance Studies, Boston, Massachusetts, November 1981.

13. James W. Sewall, Co., of Old Town, Maine, Topographic Maps, Scale 1:2,400, Contour Interval 5 Feet: North Hampton, New Hampshire, 1979.

14. U. S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water Surface Profiles, Users Manual, Davis, California, August 1979.

15. U. S. Army Corps of Engineers, Coastal Engineering Research Center, Shore Protection Manual, Volume I, Fort Belvoir, Virginia, 1973.

16. U. S. Department of the Interior, Geological Survey, Water Resources Investigations 79-61, Coastal Flood of February 7, 1978, in Maine, Massachusetts, and New Hampshire, Boston, Massachusetts, 1979.

17. Federal Emergency Management Agency, Flood Insurance Study, Town of Hampton, Rockingham County, New Hampshire (Unpublished).

18. Federal Emergency Management Agency, Flood Insurance Study, Town of Rye, Rockingham County, New Hampshire (Unpublished).

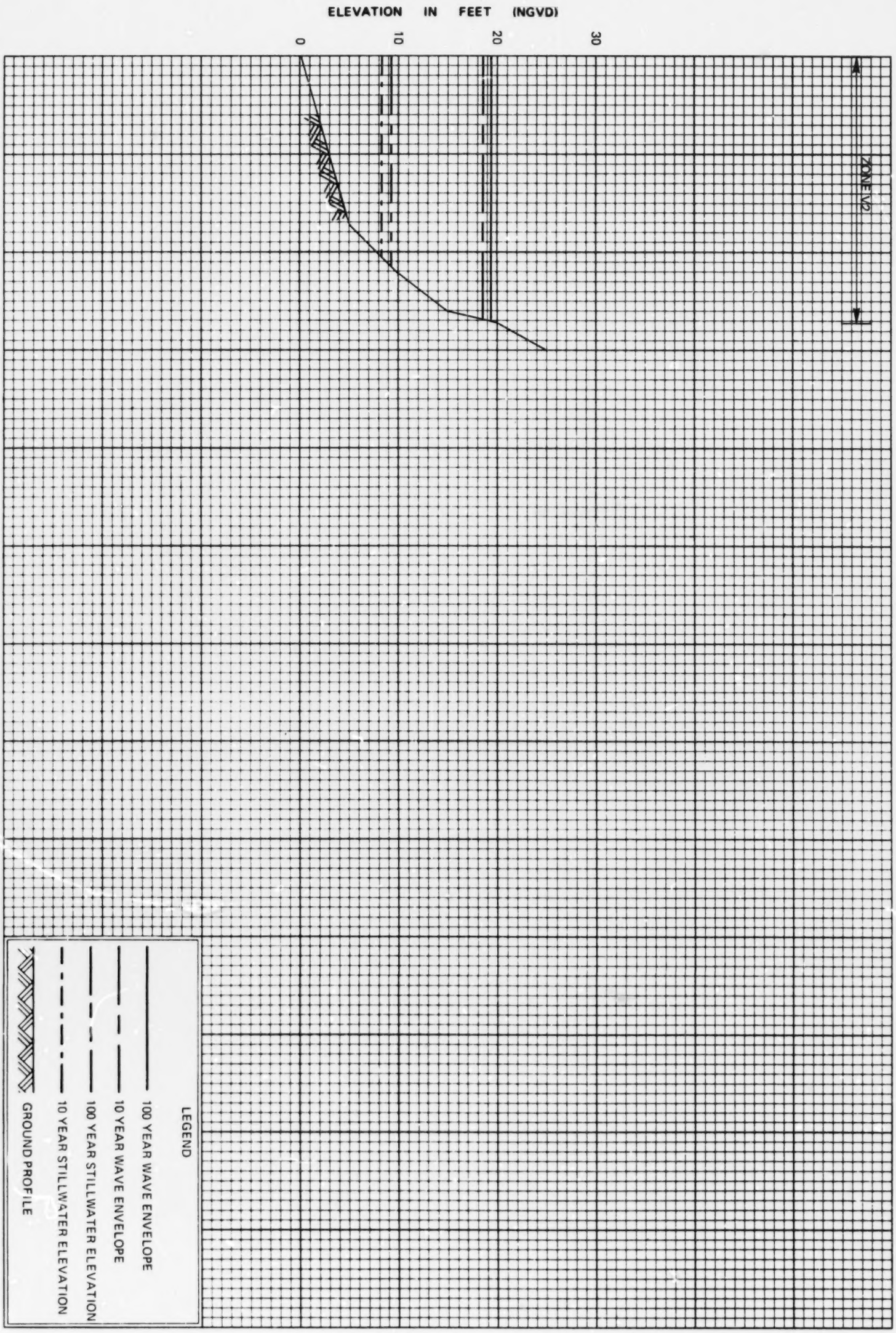
19. Federal Emergency Management Agency, Flood Insurance Study, Town of Stratham, Rockingham County, New Hampshire (Unpublished).

20. Federal Emergency Management Agency, Flood Insurance Study, Town of Greenland, Rockingham County, New Hampshire (Unpublished).

U. S. Army Corps of Engineers, New England Division, Report on the Assessment of Flood Damage Resulting from the Storm of February 6-7, 1978, along the Coastline from Orleans, New Hampshire, to New Castle, New Hampshire, Waltham, Massachusetts, February 1979.

U. S. Army Corps of Engineers, New England Division, Tidal Flood Profiles, New England Coastline, Waltham, Massachusetts

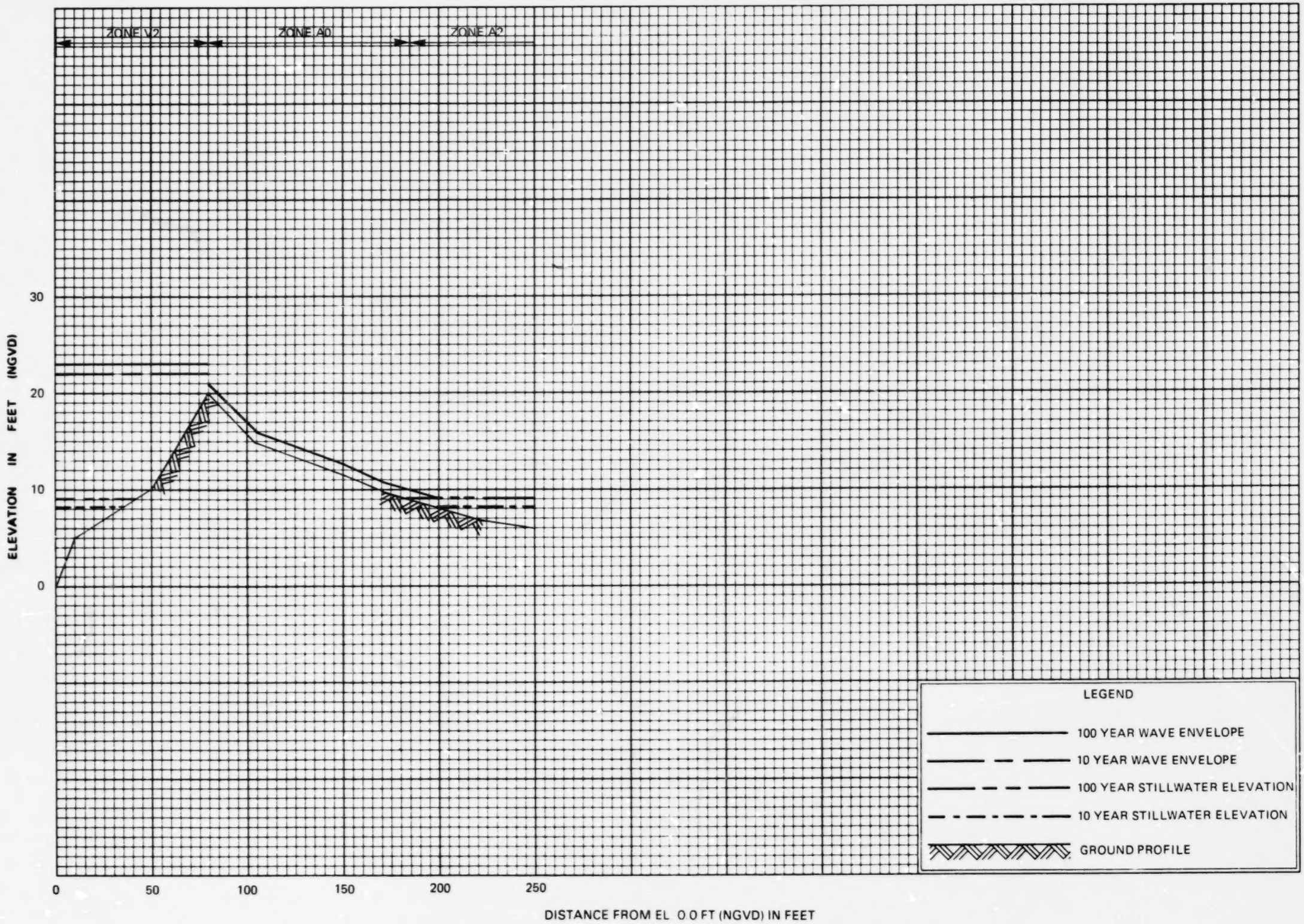
BEST COPY AVAILABLE



24

BEST COPY AVAILABLE

01C	FEDERAL EMERGENCY MANAGEMENT AGENCY **TOWN OF NORTH HAMPTON, NH** (ROCKINGHAM CO.)	**COASTAL PROFILES** **TRANSECT 1**



COASTAL PROFILES

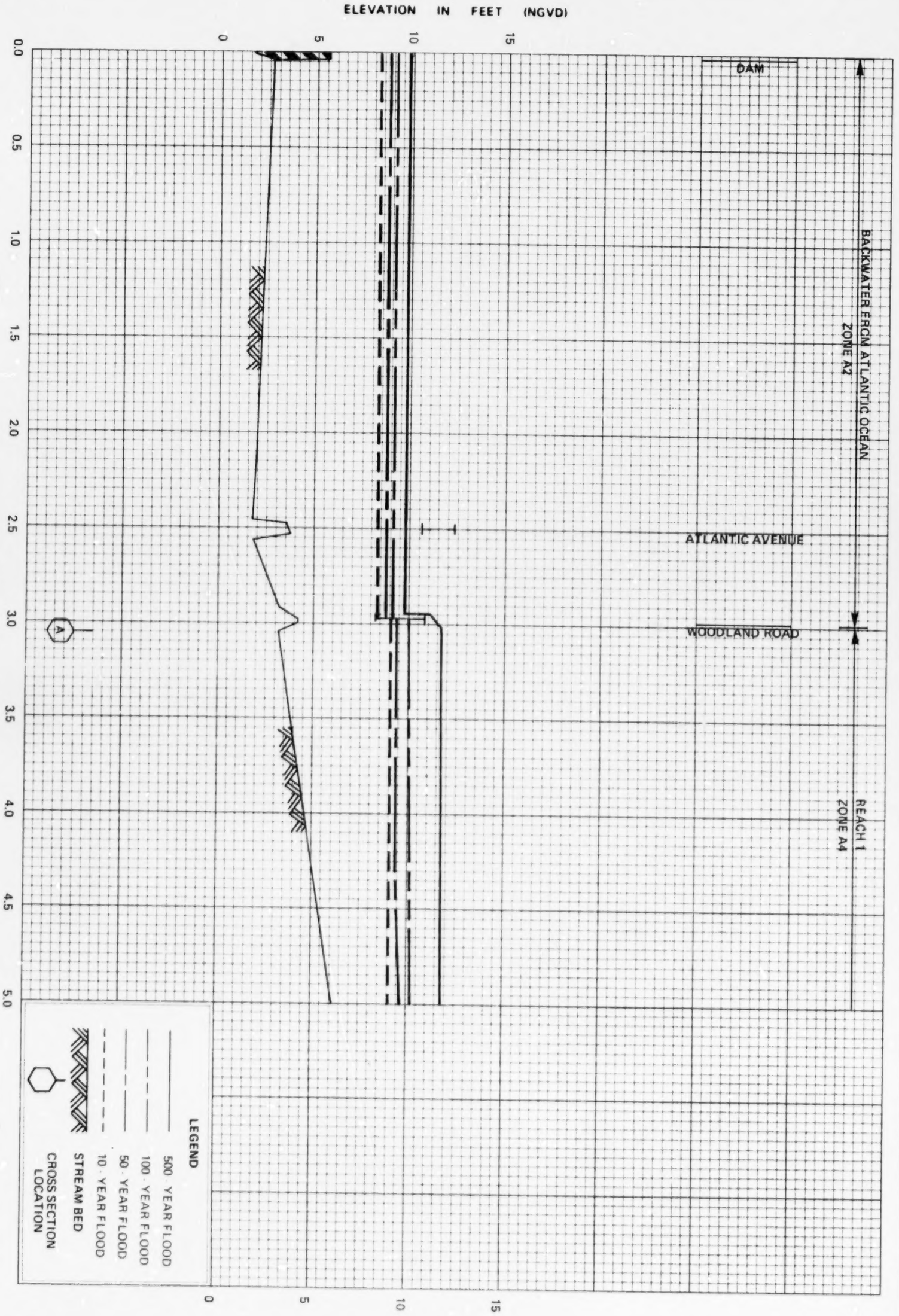
TRANSECT 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NORTH HAMPTOMN, NH
(ROCKINGHAM CO.)

02C

BEST COPY AVAILABLE



FEDERAL EMERGENCY MANAGEMENT AGENCY

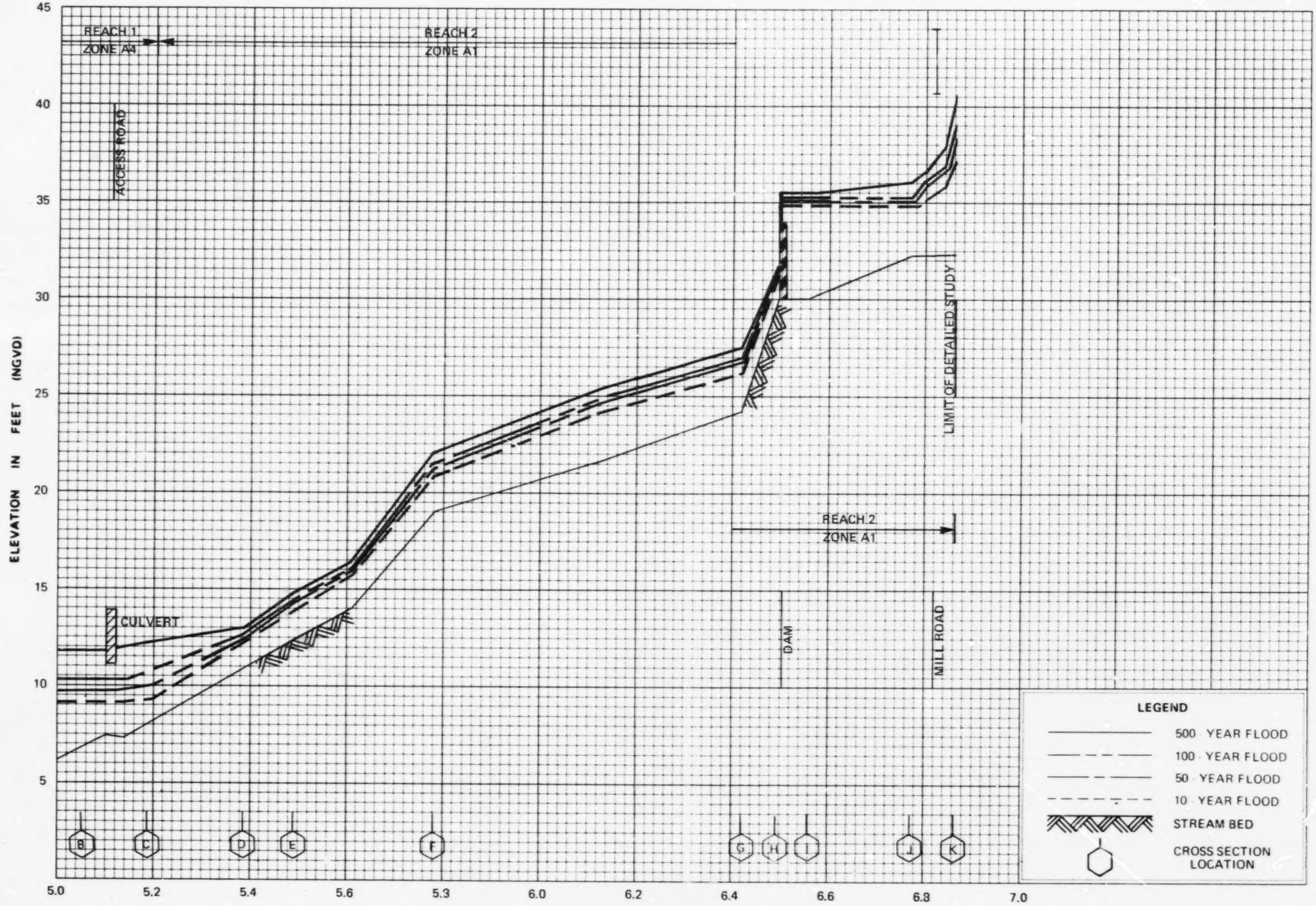
TOWN OF NORTH HAMPTON, NH
(ROCKINGHAM CO.)

FLOOD PROFILES

LITTLE RIVER

01P

BEST COPY AVAILABLE



FLOOD PROFILES

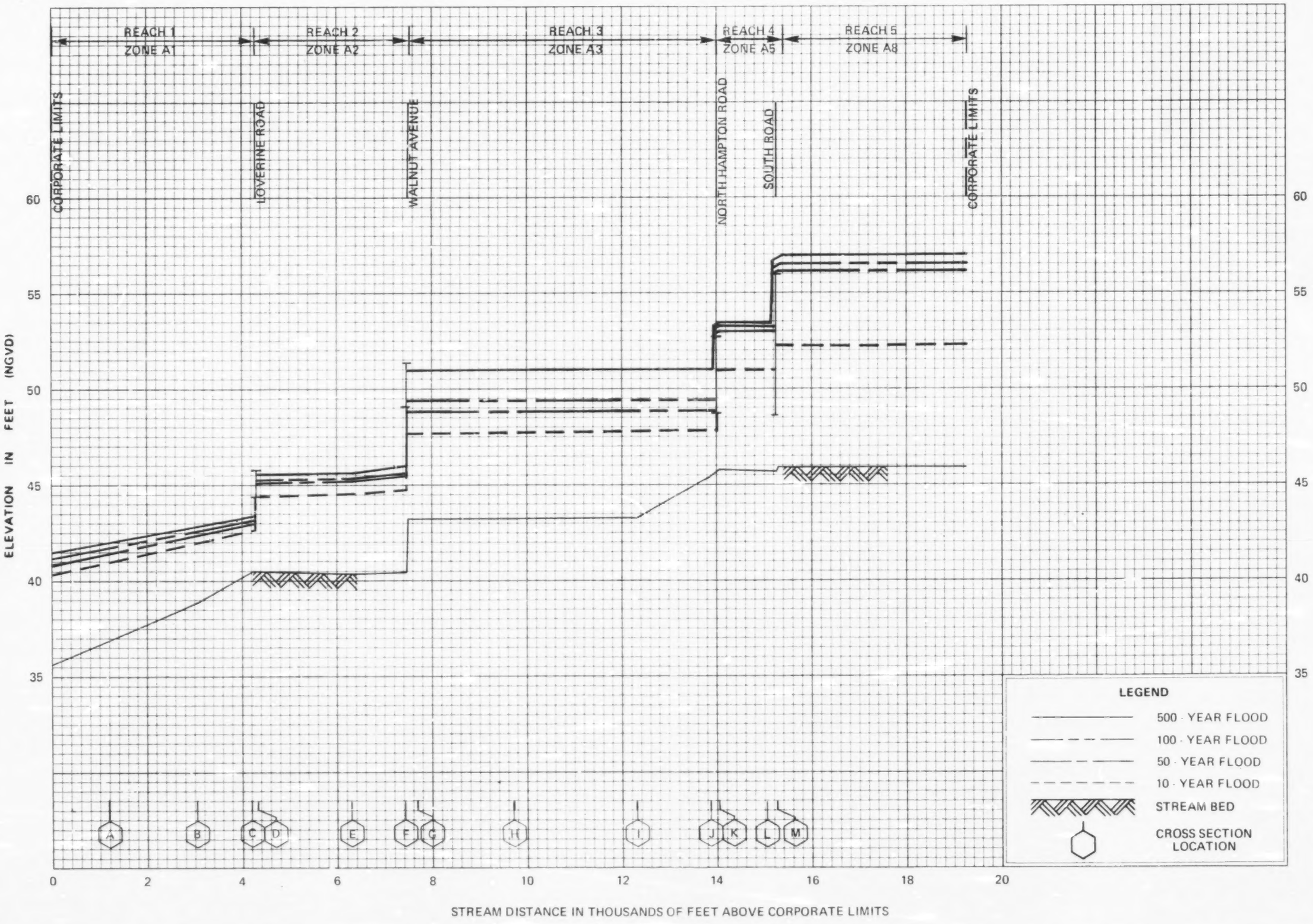
LITTLE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NORTH HAMPTON, NH
(ROCKINGHAM CO.)

02P

BEST COPY AVAILABLE



FLOOD PROFILES

WINNICUT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF NORTH HAMPTON, NH
(ROCKINGHAM CO.)

03P

BEST COPY AVAILABLE